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The breakdown of functional categories in Greek aphasia: Evidence from agreement, tense, and aspect

Spyridoula Varlokosta
University of the Aegean, Rhodes, Greece
Natalia Valeonti and Maria Kakavoulia
Panteion University, Athens, Greece
Mirto Lazaridou and Alexandra Economou
University of Athens, Greece
Athanassios Protopapas
Institute for Language & Speech Processing, Athens, Greece

Background: Verbal inflectional errors are among the most prominent characteristics of aphasic nonfluent speech. Several studies have shown that such impairment is selective: subject–verb agreement is relatively intact while tense is severely impaired. A number of researchers view the deficit as *structural* and attribute errors to a breakdown of functional categories and their projections. Agrammatic individuals are thought to produce trees that are intact up to the Tense node and "pruned" from this node up.
Aims: The present study investigates (a) the relative sensitivity of functional categories related to verbal inflection in Greek aphasia and the systematicity thereof; and (b) the relation between patterns of impairment in production and grammaticality judgements.
Method & Procedures: We present results from a sentence completion and a grammaticality judgement task with seven Greek-speaking aphasic individuals and seven control participants matched for age and education. Materials were constructed to assess three functional categories: subject–verb agreement, tense, and aspect. Eight verbs were used, balancing estimated familiarity and regularity of aspectual conjugation.
Outcomes & Results: A great variability was observed among participants in overall performance but the pattern of performance was quite systematic. The results indicated that inflectional morphemes are not all impaired to the same degree in Greek aphasia. In both tasks, as a group, patients made more errors in aspect than in agreement. The group differences between tense and the other two conditions did not reach statistical significance. Moreover, a comparison of individual aphasic performance in the three functional categories indicated that in every case in which statistically significant

Address correspondence to: Spyridoula Varlokosta, Department of Mediterranean Studies, University of the Aegean, 85100 Rhodes, Greece. E-mail: varlokosta@rhodes.aegean.gr

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differences were observed among the three functional categories, agreement was found to be less impaired than tense, aspect, or both.
Conclusions: These findings do not support a global impairment of inflectional morphemes in aphasia but support a selective one and, in particular, a dissociation between agreement, on the one hand, and tense and/or aspect, on the other hand. Moreover, our findings do not support a hierarchical account along the lines of Friedmann and Grodzinsky (1997) but are compatible with Chomsky's (2000) Minimalist Program and with Wenzlaff and Clahsen's (2004) tense underspecification theory.

VERBAL INFLECTION AND FUNCTIONAL CATEGORIES IN APHASIA

A number of studies in the past three decades have shown that inflectional errors are among the most prominent characteristics of aphasic nonfluent speech (Berndt & Caramazza, 1980; Caplan, 1985; Goodglass, 1976; Grodzinsky, 1984; among others). More recent studies, however, provide evidence that such impairment is selective and that not all inflectional morphemes are equally disturbed. In particular, with respect to verbal inflection, several studies present evidence that subject–verb agreement is relatively intact (De Bleser & Luzzatti, 1994; Friedmann & Grodzinsky, 1997; Höhle, 1995; Wenzlaff & Clahsen, 2004) while tense is severely impaired (Friedmann & Grodzinsky, 1997; Höhle, 1995; Wenzlaff & Clahsen, 2004). Nonetheless, clear patterns of impaired and spared aspects of verb morphology production are not always observed. For example, Burchert, Swoboda-Moll, and De Blesser (2005) found no overall tense-agreement differences in their agrammatic subjects and no consistently better tense or agreement performance in the two subjects who showed significant dissociations between the two functional categories using a sentence completion task.

A number of researchers view the deficit that nonfluent individuals exhibit as a deficit in the performance of syntactic computations and thus attribute verbal inflectional errors to a breakdown of functional categories and their projections (Friedmann & Grodzinsky, 1997; Grodzinsky, 2000; Hagiwara, 1995).[1] Specifically, Friedmann and Grodzinsky (1997) have argued that impairment in agrammatic production can be characterised in terms of a deficit in the syntactic tree. Based on a dissociation between agreement and tense inflection in the production of a Hebrew-speaking agrammatic subject and assuming a bottom-up derivation along the lines of (1), they propose that the syntactic trees of agrammatic individuals are intact up to the T(ense) node but "pruned" from that node up.

(1) $CP > TP > NegP > AgrP > VP$

Friedmann and Grodzinsky's (1997) tree-pruning hypothesis (TPH) does not entail an impairment necessarily in the T(ense) node; any node in the derivation can be impaired. However, a clear prediction follows from such an account: if structure building is impaired at a given level of projection, no higher-level projections can

[1] Other researchers have suggested that difficulties in the production of particular inflectional morphemes are due to processing limitations (Crain, Ni, & Shankweiler, 2001; Hofstede & Kolk, 1994; Kolk & Hartsuiker, 2000). Within such accounts, grammatical representations are intact but access to them is impaired. We do not discuss processing accounts in this paper because our testing did not include an independent measure to assess processing capacity.

be constructed but lower-level projections will be intact. Variability in aphasic performance as a function of degree of severity of aphasia thus should follow predictable patterns of impairment. Different groups of aphasic speakers encounter difficulties at particular projections. For example, in some individuals both the Tense Phrase (TP) and the Complementiser Phrase (CP) nodes may be impaired, while in others only the CP node may be affected. What distinguishes one group from another is "the level in the syntactic tree at which the deficit (pruning) occurs" (Friedmann & Grodzinsky, 1997, p. 420). Mild impairment will affect only high nodes (i.e., CP), a more severe one will implicate TP, while a very severe one will affect lower nodes as well higher ones. The lower the defective node, the greater the number of impaired functional categories and, hence, the more severe the impairment. Importantly, according to Grodzinsky (2000, p. 16), dissociations between particular projections, such as between Tense and Agreement are production-specific and are not necessarily found in grammaticality judgement.

Wenzlaff and Clahsen (2004), on the other hand, explain the patterns of impairment in verbal inflection in terms of Chomsky's (2000) Minimalist Program. This account, which does not assume a hierarchical order between separate tense and agreement projections, also predicts preserved agreement and impaired tense because the functional category tense is underspecified in agrammatism. However, in contrast to Grodzinsky's (2000) assertion that the dissociation between tense and agreement is specific to production, Wenzlaff and Clahsen found the dissociation between tense and agreement to be manifested in both production and grammaticality judgement, suggesting a central representational deficit.

Two further points need to be addressed. Severity variation across individuals may manifest in similar profiles but in different absolute levels of performance. Although Friedman and Grodzinsky (1997) do acknowledge the existence of severity variation, for them a node or functional category is impaired when all or most exemplars within that node show impairment. However, varying levels of impairment in a functional category are commonly observed in the studies. Selectively excluding patients on the basis of production patterns that are associated with Broca's aphasia does not address the issue of level of severity and may bias the analysis of the observed deficits (see Berndt & Caramazza, 1999).

A related question is whether impairment in a functional category is associated with a particular aphasic diagnostic category, type of patient, or lesion site. It has been observed in a number of studies that impairment in the comprehension of syntactic structures is not limited to agrammatic aphasic individuals or even to Broca's aphasic individuals (Dick, Bates, Wulfeck, & Dronkers, 1998; see Dick, Bates, Wulfeck, Utman, Dronkers, & Gernsbacher, 2001). Furthermore, damage to Broca's area does not necessarily cause Broca's aphasia (Mohr, Pessin, Finkelstein, Funkenstein, Duncan, & Davis, 1978) and, conversely, Broca's aphasia is not necessarily caused by damage to Broca's area (Dronkers, Shapiro, Redfern, & Knight, 1992). Therefore, the case for a priori selection of patients is very weak, whether selection is made on the basis of diagnostic subtypes or on the basis of lesion location. Any type-related conclusions should be reached only on the basis of empirical dissociations observed in groups of unselected individuals with aphasia.

Inflectional errors have been reported in studies of Greek nonfluent aphasia (Plakouda, 2001; Stavrakaki & Kouvava, 2003; Tsapkini, Jarema, & Kehaya, 2001, 2002). The issue of the alleged breakdown of functional categories related to verbal inflection is discussed in Plakouda (2001) on the basis of an experiment with a

Greek-speaking nonfluent aphasic speaker with agrammatic speech output. The results of a sentence completion task designed to assess three functional categories, namely subject–verb agreement, tense, and aspect, indicated that the most problematic category was that of aspect, with only 60% correct responses. Tense and agreement were relatively intact, with 95% and 87% correct responses, respectively. These findings were taken as evidence against the TPH or any type of account that explains verbal inflectional errors in nonfluent aphasia as a deficit in the syntactic tree.

Stavrakaki and Kouvava (2003) presented an investigation of two Greek-speaking nonfluent aphasic subjects with characteristics of agrammatic speech. The results of a range of tasks (spontaneous speech, picture description, grammaticality judgement, and preference test) showed a clear task effect on the patients' performance. The results of the spontaneous speech data indicated that both patients encountered some difficulties in the production of past tense forms (64% and 82.5% correct responses) and that most of the errors were found in contexts of high syntactic complexity, e.g. contexts where the subject had to use a C(omplementiser). Aspect errors were found exclusively in contexts of perfective aspect (52% and 78% correct responses), whereas agreement reached high percentages of correct use, with only a few problems for one patient. Crucially, the results of a grammaticality judgement task indicated high level of performance by both patients on past tense marking as well as on subject–verb agreement (rate of correct responses over 80%). Similarly, high level of performance with respect to these categories was also found in the preference test. These findings were interpreted by Stavrakaki and Kouvava as evidence against structural accounts and in favour of processing ones.

Tsapkini et al., (2001) investigated verbal morphology (specifically tense) in a Greek patient with nonfluent aphasia through a series of different tasks (spontaneous speech, sentence–picture matching, repetition, reading, and elicitation tasks). They observed problems particularly in production, with more errors in the computation of rule-based forms than forms with stem-allomorphy. More importantly, they found that difficulties arise not just when the subject has to compute one operation, specifically the rule-based perfective suffix, but when more complex computations are needed, as in the case where the subject has to compute the perfective suffix and access at the same time an allomorphic form of the verb. To account for their observations regarding inflectional impairments in the Greek verb, Tsapkini et al. proposed a computational load deficit in processing the perfective rule together with the allomorphic stem.

VERBAL INFLECTION AND CLAUSE STRUCTURE IN GREEK

(Modern) Greek is a highly inflected, null-subject language with relatively free word order (Holton, Mackridge, & Philippaki-Warburton, 1997). Each verb in Greek is formed by a combination of a stem and an inflectional ending that expresses a complex system of grammatical categories, such as agreement (first, second, and third person, singular and plural number), tense (past, non-past), aspect (perfective, imperfective), voice (active, passive) and mood (imperative, non-imperative) (Holton et al., 1997). The agreement paradigm distinguishes six inflections, as illustrated in Table 1 for the present tense of the active voice.[2]

[2] Greek does not have infinitives and the only non-finite forms are the gerund and the non-finite form that is used to compose the perfect tenses.

TABLE 1
The Greek agreement paradigm for the present tense in the active voice

Person	*Singular*	*Plural*
1st	-o	-omɛ/umɛ
2nd	-is	-ɛtɛ
3rd	-i	-un(ɛ)

TABLE 2
The interaction of aspect and tense in Greek

	Imperfective	*Perfective*
Present	pɛz-o "I am playing", "I play"	n.a.
Past	ɛ-pɛz-a "I was playing"	ɛ-pɛks-a "I played"
Future	θa pɛz-o "I will be playing"	θa pɛks-o "I will play"
na-construction	na pɛz-o "to be playing"	na pɛks-o "to play"

For the verb "play" with the imperfective stem pez- and the perfective stem peks-.

Greek makes an aspectual distinction between perfective and imperfective aspect (Holton et al., 1997; Moser, 1994). The aspectual distinction shows up in the past tense, in the future tense,[3] and in the *na*-construction.[4] In the present tense there is no aspectual distinction, that is, the present tense always uses the imperfective stem. Table 2 illustrates the interaction of aspect and tense in Greek.

Greek presents three different types of active past-tense formations (Ralli, 1988) challenging thereby the established dichotomy between rule-based vs. stored allomorph mechanisms: (a) a rule-based paradigm, which includes verbs with a phonological change, e.g., *γraf-o* ("I write"), *e-γrap-s-a* ("I wrote") or *lin-o* ("I untie"), *e-li-s-a* ("I untied"). In the presence of the aspectual marker *-s-*, there is a phonological alternation in the former case and a stem-final consonant deletion in the latter one; (b) a stored allomorph paradigm, which includes verbs with a stem-internal change, e.g., *plen-o* ("I wash"), *e-plin-a* ("I washed"); (c) a mixed paradigm, which includes verbs with both an allomorph and the addition of the aspectual marker *-s-*, e.g., *mil-o* ("I speak"), *mili-s-a* ("I spoke").

Given the richness of the Greek inflectional paradigm, several functional categories are instantiated in the extended projection of the Greek verb. The order of some of the categories remains controversial because Greek is a language in which most inflectional forms are fused. Nonetheless, a number of proposals have been put forward regarding the organisation of clause structure in Greek on the basis of the most transparent verb forms (Philippaki-Warburton, 1973, 1990, 1998; Tsimpli,

[3] The future tense in Greek is expressed by the particle θα combined with a non-past form (perfective or imperfective) (see Table 2). When the particle θα combines with a past form, it expresses a number of modalities (e.g., θα epeza *"I would play") (Holton et al., 1997).*

[4] In modal and other embedded contexts where languages like English use an infinitive, Greek makes use of a verb form introduced by the particle *na* and inflected for subject–verb agreement and aspect. This construction, referred to here as the *na*-construction, expresses formally the subjunctive in Greek (Philippaki-Warburton & Veloudis, 1984; among others).

1990; among others). According to Philippaki-Warburton (1990, 1998), the likely clause structure for Greek with respect to agreement, tense and aspect is (2):

(2) CP > MoodP > NegP > **FutP** > **AgrP** > **TP** > VoiceP > **AspectP** > **VP**

Aspect is placed nearest to the verb root because it affects the verb morphology as it very often causes internal stem modification (e.g., imperfective *per-n-o* "I am taking/ I take", perfective θ*a par-o* "I will take" and *pir-a* "I took"). This placement of aspect is uncontroversial.

With respect to agreement and tense, which appear fused in many verb forms (e.g., γ*raf-o* "I am writing", *e*γ*raf-a* "I was writing" where the final *-o* and *-a* signify both agreement and tense), it has been argued by Philippaki-Warburton (1998, p. 161) that Agr is syntactically a more peripheral category than T because in a number of verb forms the exponents of T clearly precede those of Agr. For example, in γ*raf-i-s* "you are writing", *e*γ*raf-e-s* "you were writing", θ*a* γ*raf-ti-s* "you will be written/registered", γ*raf-tic-e-s* "you were written/registered" the final *-s* marks second person, while *-i* vs. *-e* and *-ti* vs. *-tic-e-* mark the difference between present and past, respectively.[5] Finally, based on a number of similarities between indicative forms and forms with the future particle θ*a*, Philippaki-Warburton (1998, pp. 166–170) argues that θ*a* (unlike the subjunctive particle *na*) is not a mood marker situated in the mood phrase (Rivero & Terzi, 1995) but a particle within the indicative that marks future and hosts its own projection, namely FutP.

The purpose of the present study is to investigate (a) the relative sensitivity of functional categories in Greek aphasia and the systematicity thereof; and (b) the relation between patterns of impairment in production and grammaticality judgements. As discussed above, both agreement and tense are considered to be higher in the clause structure of Greek than aspect, which is the category located closest to the verb root. Given such a hierarchy, TPH would predict that aspect should be the least impaired category in Greek aphasia, showing impairment only in the most severely affected patients, who would also show impairment in tense and agreement. Furthermore, since TPH is a production theory, dissociations between particular projections are not necessarily expected in grammaticality judgements. Wenzlaff and Clahsen's (2004) tense underspecification theory, on the other hand, would predict preserved agreement relative to tense in both production and grammatically judgement.

METHOD

Participants

Seven individuals (all male) clinically diagnosed with aphasia ("patients") participated in the study, their ages ranging between 42 and 81 years. All patients had had a single cerebrovascular accident at least 3 months prior to testing (except for P5 who had also experienced another CVA 5 years ago) and were judged by a

[5] On the other hand, based on the distribution of object clitics in future tense clauses, Tsimpli (1990) has proposed that TP is higher than AgrP in the clause structure of Greek. However, the precise order of Agr and T are not relevant to our study given that Asp is the category located lowest in the functional hierarchy of Greek.

speech pathologist to be free of dementia. All aphasic patients who were located by the investigators and who agreed to participate were included in the study. No patient was excluded because of diagnostic category or severity of aphasia. An eighth patient was excluded from the study because of inability to participate in the production tasks due to the aphasia. Because there are no standardised language tests or common materials in Greek, a control group of seven male individuals without aphasia (''controls'') was employed in order to obtain a reference measure of performance for the specific tasks we used. Each individual was matched to one participant with aphasia, to the extent possible, on age and (years of) education. The controls had no reported history of neurological or psychiatric disorder nor any memory difficulties. They had no significant anxiety or depression, were not taking any psychoactive medication, and were not under any treatment interfering with cognitive function. All participants in the study were right-handed. All participants were non-paid volunteers living independently at home. Table 3 lists the participants' individual information.

Materials

Testing included an interview, a picture description task, a grammaticality judgement task, and a sentence completion task.

The pictures that were described were Cookie Theft from the Boston Diagnostic Aphasia Examination (BDAE; Goodglass & Kaplan, 1983) and Scene 2 (Department Store) from the Wechsler Memory Scale-III (WMS-III; Wechsler, 1997). The collected speech samples were analysed following the procedures of Thompson, as described in Faroqi-Shah and Thompson (2004). In brief, the speech samples from the picture descriptions were analysed for the following parameters: mean length of phrase; proportion of grammatical phrases (out of the total number

TABLE 3
Participant information

N	*Initials*	*Age*	*Sex*	*Education (years)*	*Type of stroke*	*Clinical diagnosis of aphasia*	*Time post-onset*
P1	BM	54	M	16	ischaemic	Wernicke's	4 yr
P2	PI	81	M	12	ischaemic	nonfluent	2.5 yr
P3	TK	62	M	6	ischaemic	nonfluent	10 mo
P4	CA	64	M	6	ischaemic	nonfluent	4 mo
P5	AN	55	M	16	unknown	anomic	2.5 yr
P6	AK	42	M	16	haemorrhagic	nonfluent	5 mo
P7	NN	57	M	16	haemorrhagic[a]	fluent[b]	12 mo
C1	TD	52	M	16	–	–	–
C2	AA	79	M	13	–	–	–
C3	RA	57	M	6	–	–	–
C4	FI	62	M	3	–	–	–
C5	GA	52	M	18	–	–	–
C6	FD	43	M	14	–	–	–
C7	EI	56	M	16	–	–	–

[a]Secondary to removal of left temporal lobe meningioma.
[b]Initially diagnosed with Broca's aphasia; at the time of study fluent with grammatical deficits.

of phrases); and ratio of open-class to closed-class words. In accordance with Faroqi-Shah and Thompson, a combination of reduced mean length of phrase and production of at least a few agrammatic phrases was considered evidence for agrammatism. Omission of function words, as evidenced by high ratio of open-class to closed-class words, is provided for descriptive purposes only, because of its unproven usefulness as a measure of agrammatism in a language with rich morphology like Greek.

For the grammatical tasks, sentences were constructed using eight transitive, two-syllable verbs, stressed on the penultimate syllable in their base form. Half of the verbs formed a regular perfective aspectual theme (with prefix *e-* and infix *-s-*) and the other half were irregular (including at least a root vowel change). Regularity was crossed with familiarity, resulting in half of the verbs in each condition being of high familiarity and the other half of low familiarity. Only written word frequency is available for Greek, based on text corpora containing a large proportion of news, literary and legal texts (Hatzigeorgiu et al., 2000). Written word frequency counts may offer poor estimates of spoken usage for certain common everyday words: in the low-frequency range, two words of similar printed frequency can differ greatly in familiarity (Gernsbacher, 1984). Therefore, in order to assess familiarity, 15 elderly adults (not the control participants) with no known neurological condition rated the familiarity of the pre-selected verbs on a scale of 1 (low: used "rarely, if ever") to 5 (high: used "every day"). Table 4 lists the chosen verbs and their main characteristics. Each familiarity–regularity pair includes one verb with a consonant cluster and one with no clusters.

Using these eight verbs, sentences were constructed to test for agreement, tense, and aspect. The sentences were as simple as possible while allowing constraint of the desired verb type (e.g., including a temporal term for tense). Every sentence was

TABLE 4
Properties of the eight verbs used to construct the test sentences

No	*Present (imperfective)*	*Past (perfective)*	*Regularity*	*Mean subjective familiarity*[(a)]	*Estimated frequency*[(b)]	*Consonant cluster in stem*
1	γrafo "I write"	εγrapsa "I wrote"	regular	4.1	frequent	Yes
2	xano "I lose"	εxasa "I lost"	regular	3.4	frequent	No
3	plɛko "I weave"	εplɛksa "I wove"	regular	1.8	infrequent	Yes
4	ðɛno "I tie"	εðɛsa "I tied"	regular	2.6	infrequent	No
5	vlɛpo "I see"	iða "I saw"	irregular	4.7	frequent	Yes
6	ðino "I give"	εðosa "I gave"	irregular	4.5	frequent	No
7	ðɛrno "I beat"	εðira "I beat"	irregular	2.5	infrequent	Yes
8	cɛo "I burn"	ɛkapsa "I burned"	irregular	2.1	infrequent	No

[(a)]Determined experimentally in a pre-test (see text).
[(b)]Categorisation on the basis of the familiarity estimate, using a cutoff of 3.

affirmative and included only one verb, in the active voice. All verbs were used in the construction of sentences for all grammatical category conditions. For all conditions, target (base) sentences were constructed first. Each target sentence was subsequently complemented with one corresponding cue sentence (for the sentence completion task) and one incorrect sentence (for the grammaticality judgement task). The cue and incorrect sentence were matched for contrastive type. For example, to test number agreement in the plural, compared against the singular, the following base sentence was constructed: "emis vlepume ti vroçi" ("We watch$_{(1st.pl)}$ the rain"). From this, the cue sentence was "eγo vlepo ti vroçi" ("I watch$_{(1st.sg)}$ the rain") and the incorrect sentence was "emis vlepo ti vroçi" ("We watch$_{(1st.sg)}$ the rain"). The rationale for this set derived from the intended tasks: in the sentence completion task, the cue sentence was to be given to the participant in order to elicit the target (base) sentence; in the grammaticality judgement task, both the incorrect and target sentences were to be (separately) offered for judgement.

For the agreement condition, 32 base sentences were constructed (4 for each verb, 1 in each of the tested forms), half for number and half for person (number and person were tested in separate sentences). Base types were in the present tense, always in the plural for number, and in the first or second person for person. Number was tested in the first and third persons. Contrastive types for person were always first person for the second-person base, and third person for the first-person base. For example, one test item for the agreement condition was "o manos γrafi ena γrama || emis _____" ("Manos writes a letter. We _____"). It was not feasible to test every possible contrast between persons, because the duration of the test would exceed the tolerance of the patients, but in this way there is a fairly wide range of types and contrasts within agreement.

For the tense condition, 16 base sentences were constructed (2 per verb), using the imperfective aspect, half in the past and half in the future. All contrastive types for tense were in the present, which is considered to be the unmarked case, and were matched for aspect, person, and number. For instance, the following test item was given in the tense elicitation task: "i popi vlepi tileorasi || xθes i popi _____" ("Popi watches TV. Yesterday Popi _____").

For the aspect condition, 32 base sentences were constructed (4 per verb), half in the perfective and half in the imperfective aspect. Of each group, half were in the past and half were in the future. Contrastive types were in the opposite aspect, matched in person, number, and tense. An example of the imperfective aspect production task is the following test item: "xθes i γramateas olo to proi eγrafe tin epistoli || xθes i γramateas se eksi lepta _____ tin epistoli" ("Yesterday all morning the secretary was writing the letter. Yesterday the secretary in 6 minutes _____ the letter").

The sentence completion task was constructed by pairing each complete cue sentence with the corresponding base sentence up to the word preceding the verb. Thus, for the aforementioned base sentence "emis vlepume ti vroçi" the test item would be "eγo vlepo ti vroçi. emis ____" ("I watch the rain. We ____"). The total number of items in the sentence completion task was 80. For the aspect condition only, because of the greater sentence length needed to constrain the intended form, only the critical verb was missing from the written cue and not the remainder of the sentence.

The grammaticality judgement task was made up of the list of base sentences and the list of corresponding incorrect sentences. Equal numbers of correct and incorrect items, totalling 160, were used in the grammaticality judgement task.

Procedure

Each person was tested individually at home or at the speech therapy clinic. For most of the patients, presence of a family member and/or a speech therapist was necessary to provide emotional support during the interaction. This person was instructed to refrain from interfering with the test administration and to remain silent while the patient was formulating the responses.

Testing took place in one (P5, P6, and P7), two (P3 and P4) or three (P1 and P2) 30- to 55-minute long sessions; when more than one session was necessary the sessions were spaced 1 or more days apart. The participant was first administered the interview and production tests, followed by the picture description and grammaticality judgement test, in a fixed order. Testing was interrupted when fatigue or emotional reactions were obvious. For controls, testing was completed in a single session, with a short break in the middle. All testing was tape recorded, and all scoring was later verified from the recordings.

For the sentence completion test, the experimenter first explained the task and provided two or more examples, until it was clear that the participant was responding appropriately. Cue sentences were presented orally and, for the patients only, also in print at the same time. The participant always responded orally. Explanations were sometimes necessary to avoid semantic responses (such as responding to "I write a book. You ___" with "you read it"). No additional explanation or help was given during administration of the test items unless it was clear from the participants' responses and comments that an inappropriate strategy was used. The three conditions (agreement, tense, and aspect; always in this order) were blocked whereas the order of items within each condition was randomised (once and held the same for all participants). During task procedure self-corrections were allowed and the final answer was the one that was analysed. If requested, the examiner repeated the cueing sentence once.

For the grammaticality judgement test, the experimenter again explained the task and provided two or more examples until it was understood. Sentences to be judged were presented orally and, for the patients, also in print. The participant always responded orally. Explanations were often necessary to avoid responses based on content rather than on form. No additional explanation or help was given during administration of the test items unless it was clear from the participants' responses and comments that an inappropriate strategy was used. As with the production task, conditions were blocked and presented in the same fixed order; item order within each condition was randomised.

RESULTS

Measurements from the picture description tasks are shown in Table 5. On the basis of low proportion of grammatical phrases and reduced phrase length, P2, P3, and P4 show evidence of agrammatism. P4 also shows a very low open- to closed-class word ratio. Note that P2, P3, P4, and P6 are diagnosed as nonfluent.

Sentence completion

Each patient, with the exception of P5 who made no errors, naturally made many more errors than the corresponding matched control participant ($\chi^2 > 12$, $p < .001$,

TABLE 5
Measurements from the picture description task for each participant

Participant	*Total words*	*MLP*	*Proportion grammatical*	*Open:closed ratio*
P1	336	10.2	0.76 *	0.82
P2	153	5.5 *	0.66 *	0.82
P3	208	6.1 *	0.73 *	0.58
P4	407	7.3 *	0.70 *	0.38 *
P5	136	10.6	0.85	0.58
P6	135	10.8	0.84	0.81
P7	141	12.8	0.52 *	0.74
C1	183	13.9	1.00	0.74
C2	254	17.1	0.87	0.61
C3	201	12.9	0.87	0.71
C4	155	18.9	1.00	0.94
C5	147	15.0	0.92	0.61
C6	166	8.7	1.00	0.71
C7	260	14.2	0.94	0.94

MLP: mean length of phrase (number of words).
*More than 2 standard deviations away from the control group mean.

or better). As a group, patients made more errors than controls in each of the three conditions (by Mann-Whitney U test, 1-tailed exact significance; agreement: $U = 9$, $p = .022$; tense: $U = 7$, $p = .010$; aspect: $U = 6.5$, $p = .010$). Table 6 summarises the performance of the participants in the sentence completion task.

Concentrating on the critical verb of the response only, we considered as error any production deviating from the correct verb lemma in its expected grammatical form for the relevant category;[6] these are counted under "total errors". A great variability was observed among participants in overall performance. However, the pattern of performance was quite systematic in that low or high error proportions in all three functional category conditions simultaneously were observed for each person. As a group, patients made more errors in aspect than in agreement[7] ($z = -2.37$ by Wilcoxon signed ranks test, exact $p = .016$, two-tailed). The group differences between tense and the other two conditions did not reach statistical significance ($p > .4$).

Testing whether individual patient performance is impaired, by comparing, for each patient, the mean number of individual errors per item in each condition to 0 (via t-test at adjusted per-patient $\alpha = .017$, one-tailed), we find that, for the sentence completion task, patients P2, P3, and P4 are impaired in all three conditions, whereas P1 and P7 are impaired in agreement and aspect (P6 missed significance, agreement: $p = .042$; aspect: $p = .022$).

We also compared individual performance to chance, by comparing the mean number of errors (per item) to the expected chance probability of 0.4167 for

[6] Therefore, in the agreement and aspect tasks any tense would be acceptable, in the tense and agreement tasks any aspect would be acceptable and so on.

[7] There was an equal (and small) number (17) of person and number total errors in the agreement condition of sentence completion, and no obvious patterns of performance. Therefore, agreement errors are presented cumulatively and not broken down into person and number.

TABLE 6
Errors

	Total errors			*Lexical errors*			*Form errors*		
Participant	*Agr*	*T*	*Asp*	*Agr*	*T*	*Asp*	*Agr*	*T*	*Asp*
Patients									
P1	15.6	12.5	43.8	0.0	0.0	0.0	15.6	12.5	43.8
P2	37.5	93.8	81.3	12.5	12.5	25.0	25.0	87.5	68.8
P3	28.1	81.3	56.3	18.8	18.8	31.3	12.5	81.3	37.5
P4	56.3	68.8	68.8	12.5	6.3	50.0	53.1	68.8	46.9
P5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
P6	9.4	0.0	12.5	0.0	0.0	0.0	9.4	0.0	12.5
P7	15.6	12.5	37.5	0.0	0.0	3.1	15.6	12.5	34.4
All	23.2	38.4	42.9	6.3	5.4	15.6	18.8	37.5	34.8
Controls									
C1	0.0	0.0	3.1	0.0	0.0	3.1	0.0	0.0	0.0
C2	9.4	0.0	12.5	0.0	0.0	3.1	9.4	0.0	9.4
C3	18.8	0.0	9.4	6.3	0.0	6.3	12.5	0.0	6.3
C4	9.4	0.0	0.0	0.0	0.0	0.0	9.4	0.0	0.0
C5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C6	0.0	0.0	3.1	0.0	0.0	0.0	0.0	0.0	3.1
C7	0.0	0.0	3.1	0.0	0.0	3.1	0.0	0.0	0.0
All	5.4	0.0	4.5	0.9	0.0	2.2	4.5	0.0	2.7

Proportion of errors (per cent, relative to the total number of test items in each category) made by each participant in each condition (Agr: agreement; T: tense; Asp: aspect) of the sentence completion task. Lexical errors include only errors in verb root; form errors include only errors in grammatical form. The two add up to more than the total because it is possible to make both types of errors in a single response.

agreement,[8] 0.3333 for tense, and 0.5000 for aspect (via *t*-test at $\alpha = .017$, one-tailed). This comparison showed that performance was no better than chance for P2 and P4 in agreement, P2, P3, and P4 in tense, and all but P5 and P7 in aspect.

We conducted a series of chi-square tests comparing individual aphasic performance in the three functional categories. After adjusting per-participant α to 0.017 (for the three comparisons: tense–aspect, tense–agreement, aspect–agreement), we found that the performance of P2 was better for agreement than for both tense or aspect, the performance of P3 was better for agreement than for tense and marginally better than for aspect, and the performance of P1 was better for agreement than for aspect (see Table 7). Therefore, in every case in which statistically significant differences are observed among the three functional categories, agreement is found to be less impaired than tense, aspect, or both. The pattern of errors among tasks and the fact that participants did not make random errors across the board suggests that the specific task requirements (computation of the particular grammatical form) constitute a major contributing factor to the observed performance failures. Thus, the tasks apparently do index the degree of difficulty of producing the particular grammatical forms for each participant.

[8] Because all productions were legal verb forms, and because errors were counted with respect to the relevant grammatical category only, the number of possible alternatives (two aspects, three tenses, and for agreement two numbers and three persons in equal proportions) allows the calculation of chance performance.

TABLE 7
Performance comparisons between functional categories

	Sentence completion			*Grammaticality judgement*		
	Agr-T	*Agr-Asp*	*T-Asp*	*Agr-T*	*Agr-Asp*	*T-Asp*
P5				2.02	1.01	0.26
P6	1.60	0.16	2.18	1.02	2.99	3.78
P7	0.08	3.93*	3.23	19.86***	25.12***	0.22
P1	0.08	6.06**	4.69*	1.02	6.94**	6.21**
P3	12.13***	5.19*	2.92	15.44***	12.95***	0.75
P4	0.70	1.07	0.00	34.35***	37.50***	0.02
P2	12.39***	11.09***	1.34	3.00	0.00	3.00

Comparison (χ^2 statistic) of individual aphasic sentence completion and grammaticality judgement among the three functional category conditions (Agr: agreement; T: tense; Asp: aspect). Patients are ordered by overall number of errors (least to most) in the sentence completion task. Blank χ^2 statistic indicates no errors.

* $p < .05$, ** $p < .017$, *** $p < .001$

However, errors are not of a single type. According to standard models of inflectional morphology (Ralli, 1988, 2004) lemma retrieval is dissociable from morphological suffixation (or other modification). Production of the intended verb in an incorrect grammatical form (a "morphological" or "form error") is clear indication of a morphological difficulty, whereas production of an incorrect verb (a "lexical error") may indicate different, or more general, difficulties in language use. Table 6 also shows, separately, the proportion of lexical and form errors for each participant. Here, any verb produced in the intended grammatical category is considered as having the correct form and, conversely, the intended verb in any form (valid or not) other than the intended one is considered as lexically correct.[9]

Again, a systematic error pattern emerges: Form errors were more numerous than lexical errors for the patients ($z = 2.20$ by Wilcoxon signed ranks test, exact $p = .03$, two-tailed), and lexical errors were made only by the more severely affected patients, in proportion to the total number of errors made by each patient. For P4, more lexical errors were seen in the aspect task than in the agreement ($\chi^2 = 10.47$) and the tense task ($\chi^2 = 8.93$; $p = .003$ for both comparisons). As for form errors, it was still the case that P2 ($\chi^2 = 16.78$) and P3 ($\chi^2 = 22.04$) showed less impaired agreement than tense (both $p < .0005$), and that P2 also ($\chi^2 = 12.30$, $p = .001$) showed less impaired agreement than aspect (P1 and P3 did not quite reach significance in this comparison: $\chi^2 = 6.06$, $p = .027$; and $\chi^2 = 5.33$, $p = .041$, respectively).

Thus, it appears that lexical errors are not only *not* dissociated from form errors (since they follow the same pattern) but likely reflect a heightened difficulty in language production, their presence alone indexing the degree of severity. This observation is in line with the hypothesis that morphological computation is more difficult than lemma retrieval, and with the relative vulnerability of grammatical morphology, relative to lexical skills, in conditions of linguistic impairment, developmental (Leonard, 1998) or acquired (Bates, Wulfeck, & MacWhinney, 1991). Alternatively, the cue sentence might simply be priming the correct lemma in

[9] Partial or incorrect computation of the intended grammatical form *as required for the specific verb* is also counted as a grammatical error. See discussion on irregular inflectional classes.

TABLE 8
Repetition and non-repetition response types

	Agreement		*Tense*		*Aspect*	
Participant	*NonRep*	*Rep*	*NonRep*	*Rep*	*Imperf*	*Perf*
Patients						
P1	3	0	1	0	11	2
P2	2	6	1	13	9	11
P3	2	2	0	10	9	2
P4	4	10	2	8	8	4
P5	0	0	0	0	0	0
P6	3	0	0	0	2	2
P7	2	0	2	0	11	0
All	16	18	6	31	51	20
Controls						
C1	0	0	0	0	0	0
C2	3	0	0	0	3	0
C3	4	2	0	0	1	1
C4	0	3	0	0	0	0
C5	0	0	0	0	0	0
C6	0	0	0	0	1	0
C7	0	0	0	0	0	0
All	7	5	0	0	5	1

For the agreement and tense conditions of the sentence completion task, number of grammatical errors made in each task broken down into repetition (“Rep”) and non-repetition (“NonRep”) response types with respect to the cue sentence (a repetition error is one that reproduces the cue form; any other response is a non-repetition error). For the aspect task, number of grammatical errors broken down into perfective (“Perf”) and imperfective (“Imperf”) errors.

the incorrect (for the response) grammatical form. If this were the explanation for the preponderance of grammatical over lexical errors, then we should observe a much higher proportion of grammatical errors made in the cue form than in any other form. Moreover, this pattern should not depend greatly on whether a marked or unmarked form is offered in the cue sentence. Table 8 shows the breakdown of agreement and tense form errors into repetition and non-repetition type. Because there are only two possible aspects, all aspect errors are necessarily of the repetition type, and therefore, for aspect, the table partitions errors into perfective and imperfective form responses. Tense shows a greater overall number of repetition errors than non-repetition errors and aspect shows a greater overall number of imperfective error responses than perfective error responses; however, none of these differences is statistically significant for the patient group (by Wilcoxon signed ranks test, $p > .3$ for the repetition vs. non-repetition comparisons, $p = .094$ for perfective vs. imperfective).

Control participants made no errors of any sort in the tense condition, but P2 and P3 made a similar number of non-repetition errors with their controls (C2 & C3), indicating perhaps that overall the elicitation forms were sufficiently clear, not prone to alternative communicative interpretations (compared with the agreement condition), and that the sentences were sufficiently brief and easy, not likely to be forgotten (compared with the aspect condition). In this light it seems important that

several participants with aphasia made a large proportion of errors in the tense condition.

Grammaticality judgement

Performance for the patient group on the grammaticality judgement was higher for the agreement condition than for aspect ($z = -2.20$ by Wilcoxon signed ranks test, exact $p = .031$, two-tailed). As for the sentence completion task, the group differences between tense and the other two conditions did not reach statistical significance ($p > .1$). As a group, patients made more errors than controls in the aspect condition (by Mann-Whitney U test, 1-tailed exact significance: $U = 5$, $p = .006$); comparisons in the other two conditions approached, but failed to reach, statistical significance (agreement: $U = 14$, $p = .090$; tense: $U = 12.5$, $p = .063$).

Testing whether individual patient performance is impaired by comparing, for each patient, the mean number of individual errors per item in each condition to 0 (via t-test at $\alpha = .017$, one-tailed), we find that only patients P2 and P3 are impaired in agreement, patients P2, P3, P4, and P7 are impaired in tense, whereas all but P5 are impaired in aspect. In comparison to chance performance (50%), there was no difference from chance in the performance of P2 in agreement, and the performance of P2, P3, and P4 in tense and aspect.

We also conducted a series of chi-square tests comparing individual aphasic grammaticality judgement in the three functional categories. After adjusting per-participant α to .017, we found that the performance of P3, P4, and P7 was better for agreement than for either tense or aspect, and that the performance of P1 was poorer for aspect than for either agreement or tense (see Table 7). Thus, similar to the sentence completion tasks, in every case in which statistically significant differences are observed among the three functional categories, agreement is found to be less impaired than tense, aspect, or both. Table 9 summarises the performance of the participants in the grammaticality judgement task.

The performance of control participants in grammaticality judgement is notably less than perfect, especially for C3. Most tense errors (10 out of 12) for participant C3 are due to the possibility in Greek (as in other languages) to express a future

TABLE 9
Grammaticality judgement task: Errors

Patient/Control	*Agr*	*T*	*Asp*	*Agr*	*T*	*Asp*
1	3.1	0.0	17.2	0.0	3.1	6.3
2	43.8	62.5	43.8	1.6	0.0	6.3
3	17.2	56.3	46.9	7.8	21.9	10.9
4	1.6	50.0	48.4	0.0	12.5	1.6
5	0.0	3.1	1.6	0.0	0.0	6.3
6	3.1	0.0	10.9	0.0	0.0	0.0
7	0.0	28.1	32.8	1.6	0.0	0.0
All	9.8	28.6	28.8	1.6	3.6	4.2

Proportion of errors (per cent, relative to the total number of test items in each category) made by each participant in each condition (Agr: agreement; T: tense; Asp: aspect) of the grammaticality judgement task. Patients (left) and matched control participants (right) appear on the same row.

TABLE 10
Acceptance/rejection errors

	Agreement		*Tense*		*Aspect*		*Total*	
Participant	*Acc*	*Rej*	*Acc*	*Rej*	*Acc*	*Rej*	*Acc*	*Rej*
Patients								
P1	0	2	0	0	5	6	5	8
P2	19	9	8	12	14	14	41	35
P3	11	0	10	8	30	0	51	8
P4	1	0	13	3	22	9	36	12
P5	0	0	0	1	1	0	1	1
P6	2	0	0	0	6	1	8	1
P7	0	0	4	5	18	3	22	8
All	33	11	35	29	96	33	164	73
Controls								
C1	0	0	1	0	4	0	5	0
C2	0	1	0	0	3	1	3	2
C3	4	1	7	0	7	0	18	1
C4	0	0	4	0	1	0	5	0
C5	0	0	0	0	3	1	3	1
C6	0	0	0	0	0	0	0	0
C7	1	0	0	0	0	0	1	0
All	5	2	12	0	18	2	35	4

Number of grammaticality judgement errors in each condition made by each participant, broken down into acceptance of incorrect sentences (Acc) and rejection of correct sentences (Rej).

event using the present tense without marking it with the future particle. Similarly, for aspect both forms can be acceptable in certain cases and this cannot be avoided (e.g., by different phrasing). Table 10 shows the number of errors made by each person in each task, separately for accepted erroneous sentences (Acc) and rejected correct sentences (Rej). It can be seen that for the controls the great majority of errors are of the acceptance type ($z = -2.21$ by Wilcoxon signed ranks test, exact $p = .031$, two-tailed), mainly in the tense and aspect conditions, where certain "erroneous" sentences can in fact be considered acceptable. For the patients a similar separation of error types is evident but the difference is not so large (a 2:1 ratio as compared with 9:1 for the controls) and it did not reach statistical significance in the group comparison ($z = -1.99$, $p = .063$; although it was individually significant by χ^2 for patients P3, P4, and P7). The difference in the proportion of "accept" vs. "reject" errors between the two groups is significant ($\chi^2 = 11.40$, exact $p = .001$, two-tailed). It appears, then, that the patients' performance is comparatively more uniformly affected, especially for those least impaired in terms of overall number of errors in grammaticality judgement (P1, P5, and P6), and that it differs fundamentally from the performance of the control participants in being genuinely impaired rather than indicative of alternative form acceptance.

In Figure 1 we plot the number of errors in each category for the two tasks by patient, ordered by "severity" as defined by the number of total errors made by each patient in the corresponding task. In addition to the similar patient orders for the

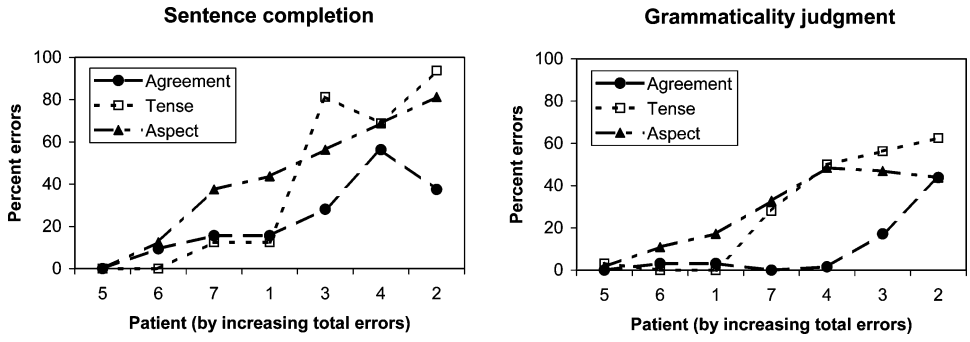

Figure 1. Percent errors per functional category in each task for each patient. The patients are ordered by number of total errors in the corresponding task, from least (left) to most (right).

two tasks, indicating comparable relative deficits in sentence completion and grammaticality judgement, the same *pattern* of deficits is seen across tasks: All three functional categories suffer as overall number of errors increases, but agreement appears to be the most resistant category, and aspect the least resistant, in the patients who showed dissociations in sentence completion or grammaticality judgement tasks.

DISCUSSION

Three patterns of production performance were observed in these patients, similar to Burchert et al. (2005). The two least impaired patients in terms of overall number of errors in production (P5, P6) showed no dissociation in performance patterns, with performance well above chance or perfect. One patient (P4) showed no dissociation in performance patterns, with performance around chance. Finally, four patients (P1, P2, P3, P7) showed a dissociation in production, with better agreement than either tense or aspect, although for P7 the difference was marginal. The same three patterns were observed in grammaticality judgement. The two least impaired patients in terms of overall number of errors in production (P5, P6) showed no dissociation in performance patterns, with performance well above chance. One patient (P2) showed overall impairment in all three categories, with no dissociation and performance around chance. Last, four patients (P1, P3, P4, P7) showed a dissociation in grammaticality judgement, with better agreement than tense or aspect. Note that P2, P3, P4, and P6 are diagnosed as nonfluent and P2, P3, and P4 showed evidence of agrammatism on the picture description tasks. The grammaticality judgement performance of the patients shows a much larger overall percentage of errors than the performance of the controls, as expected, indicating a genuine deficit in language, which nevertheless varies in degree among the patients. Thus, our narrative measures are in close agreement with performance in the grammatical task measures, in that patients with evidence of agrammatism also showed impairment in production and grammaticality judgements. Nevertheless, impairment was not limited to nonfluent patients with agrammatism, as evidenced by the dissociations in production and/or grammaticality judgements of P1, a patient with Wernicke's aphasia, and P7, with fluent aphasia.

Concerning the production performance, if participants were more likely to simply repeat the cue item in general, then they would be inclined to repeat the same

verb in particular, thus making few if any lexical errors. In that case, the three patients who made many more repetition than non-repetition form errors (P2, P3, and P4) should also make a much smaller proportion of lexical errors. In fact, the opposite pattern was observed: P2, P3 and P4 also made the highest number of lexical errors. Therefore, repetition cannot account for the discrepancy between lexical and form errors. It seems that there is a genuine computational difficulty contributing to the preponderance of form errors over lexical errors, while it remains the case that the two are far from dissociable. In other words, it seems that form errors and lexical errors, even though not coextensive, do co-occur in aphasia. This finding is in agreement with evidence for qualitative and quantitative links between lexical and grammatical deficits in aphasia and other forms of language impairments (Bates, Devescovi, & Wulfeck, 2001; Bates & Goodman, 1997; Dick et al., 2001).

Comparing the performance of patients to that of control participants, we see that each patient naturally made many more errors than the corresponding matched control participant. The latter made a few lexical errors, typically using a phonetically similar verb from the set of verbs used in the study, as well as few form errors, many of which indicated an interlocutory mode of response as opposed to the intended continuation mode (example: "I see a butterfly. You ___"; "I see a butterfly"). There was no indication of repetition tendencies or of a preferred aspect in the responses of these participants (Table 7).

We next discuss our findings in light of previous studies on inflectional errors in Greek aphasia as well as in light of theoretical approaches to inflectional errors in aphasia.

Although our results are not directly comparable to results of previous studies on Greek aphasia, because of differences in the methodologies used and in the number of participants, the following observations can be made. The findings of our sentence completion task are not entirely similar to the ones obtained by Plakouda (2001) who, using a similar methodology to ours, observed that the performance a nonfluent aphasic speaker with agrammatic speech output on the aspect task was worse than on the other two tasks and thus argued for a dissociation between aspect and the other two categories. Even though we also found worst performance on the aspect task, we would not conclude from our data that agreement and tense can be grouped together in a comparison against aspect. The pattern of performance that Plakouda's subject displayed was similar to that of P1 and P7 in our study, but not to P2, P3, and P4, who are diagnosed as nonfluent and showed evidence of agrammatism in the picture description tasks.

Some similarities as well as differences can be observed between our findings and the results Stavrakaki and Kouvava (2003) obtained through analysis of the spontaneous speech data of two nonfluent patients. Agreement in their study reached high percentages of correct use whereas some difficulties were encountered in the production of past tense forms and perfective aspect at least for one of their subjects. Stavrakaki and Kouvava found no errors in future forms, which contrasts with our findings. The proportion of errors in the future tense forms in our sentence completion task is 42.8% (24 out of 56 incorrect responses in total). Moreover, unlike Stavrakaki and Kouvava, we observed errors not only in the perfective aspect but in the imperfective as well (cf. Table 8), in statistically indistinguishable proportions. Last, although we observed an overall lower proportion of errors in the grammaticality judgement task, some patients made quite a few errors in the tense and aspect conditions (see Figure 1). In this respect, our results are different from

those in Stavrakaki and Kouvava, who found a high level of performance by their subjects on past tense marking.[10]

Let us now consider the ramifications of our findings for the various analyses proposed to explain inflectional errors in aphasia. Our results indicate that inflectional morphemes are not all impaired to the same degree in aphasia. Agreement inflection is relatively intact, while tense and particularly aspect are more severely impaired. Thus, our findings do not support a global impairment of inflectional morphemes in aphasia (Berndt & Caramazza, 1980; Caplan, 1985; Goodglass, 1976) but a selective one (De Blesser & Luzzatti 1994; Friedmann & Groszinsky, 1997), and, in particular, a dissociation between agreement, on the one hand, and tense and/or aspect, on the other hand (Friedmann & Grodzinsky, 1997; Höhle, 1995; Wenzlaff & Clahsen, 2004).

However, our findings do not support a hierarchical account along the lines of Friedmann and Groszinsky (1997). Given the clause structure of Greek shown in (2), according to which AspP is placed nearest to the verb root while AgrP is structurally more peripheral than TP, the TPH predicts that aspect would be the least impaired category while subject–verb agreement would be at least as impaired as tense, assuming the syntactic tree is pruned at the T node. However, performance on aspect and/or tense was lower than performance on agreement. Even if one assumes Tsimpli's (1990) analysis of Greek clause structure, according to which TP is higher than AgrP, the TPH does not predict impairment of the AspP. Again, on the assumption that the TP-layer is pruned (given the low performance of most patients on tense), no functional categories below it should be affected. In other words, not only AgrP but AspP should be intact, a prediction not confirmed by our data. Moreover, even if one assumes that the deficit affects not just the TP-layer but a lower-level projection, such as the AspP (an assumption allowed by the TPH), then the TPH predicts impairment of all functional categories above the pruned one (including the AgrP). However, this prediction is not borne out by our data either. Last, our findings indicated dissociations between particular projections in grammaticality judgements as well, which are not necessarily expected within TPH. To sum up, as far as the TPH is concerned, our findings are consistent with the conclusions of Plakouda (2001), as well as of Stavrakaki and Kouvava (2003), who argue that "high or low tree position in the sentence hierarchy was not the only determinant of the aphasic performance".

Instead, when a dissociation is observed, it is between agreement, on the one hand, and aspect and/or tense, on the other hand. This is consistent with Wenzlaff and Clahsen's (2004) tense underspecification theory, which predicts preserved agreement relative to tense, although predictions about aspect are not made. Thus, the asymmetry that arises is between categories that establish a structural relation between elements in the clause (subject–verb agreement) and categories that do not establish such relations but contribute to the semantic interpretation of the sentence (tense and aspect). Traditionally, tense is a grammatical category that denotes the temporal location of an event, while aspect indicates the temporal structure of an event; that is, the way in which the event occurs in time. This distinction between the above grammatical categories is reflected in recent versions of syntactic theory. Within Chomsky's (2000) Minimalist Program, categories such as agreement and tense are effectively different. Agreement is not a functional category (as in previous

[10] Stavrakaki and Kouvava (2003) did not test aspect in the grammaticality judgement task.

versions of the Principles and Parameters framework) but is considered an *operation* by which certain uninterpretable features of T are checked against certain interpretable features of the subject. Tense, on the other hand, is an interpretable feature of the *functional category* T. Something along these lines may hold for aspect as well, although not discussed in Chomsky (2000). Therefore, it appears that categories that carry interpretable features may cause more difficulties to nonfluent aphasic subjects.

In conclusion, our findings are compatible with Chomsky's (2000) Minimalist Program and with Wenzlaff and Clahsen's (2004) tense underspecification theory but not with TPH, irrespective of variations in tree structure. The performance of the aphasic participants indicates that functional categories related to verbal inflection are impaired in a systematic pattern, suggesting the existence of underlying genuine linguistic impairments. Further research is needed to replicate the pattern of impairment we have observed and to further explore the vulnerability of verb inflection in order to understand the specific linguistic deficits in Greek aphasia.

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